c.1

SECRET

097.3
Z1092
No. 1135

THE EFFECTS OF THE STRATEGIC BOMBARDMENT OF EUROPE

K+A no. 1135

Not to be shown outside
Office of Strategic
Services

DEPARTMENT OF STATE
REFERENCE DIVISION
FILE COPY
PLEASE RETURN
REF

OFFICE OF ECONOMIC WARFARE
Enemy Branch
EO 221

OFFICE ATEGIC SERVICES
Research Analysis Branch
R no. 1135

6 September 1943

This document contains information affecting the national defense of the United States within the meaning of the Espionage Act, 50 U.S.C. 31 and 32, as amended. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

If and when this study ves its usefulness to you, kincurn it to:

Office of Strategic Se
Director, Branch of Re and Analysis
25th and E Streets, N.
Washington, D. C.

TABLE OF CONTENTS

	Page
Summary of Conclusions	iii
Summary of Supporting Papers	vii
I. Introduction	1
A. The Scale of the Attack	1
B. Methods of Evaluating the Results of Bombing	2
C. Plan of the Study	5
II. The Effect of Bombardment on the General Level of Output	7
A. Summary	7
B. Factors Affecting Loss of Output	8
C. The Over-All Loss from Air Attack	9
D. Loss in Particular Industries	13
III. Effect on Specific Industries	16
A. Military Matériel	16
1. Aircraft	16
2. Tanks and Self-Propelled Artillery	26
3. Motor Trucks	28
4. Submarines	31
B. Basic Industrial Materials	37
1. Oil	37
2. Synthetic Rubber	42
3. Rubber Tires	45
4. Anti-Friction Bearings	49
5. Steel	52
C. Locomotives and Transportation	56

Page

IV. The Position of Civilians in Germany 59

A. The Effects of Bombing on the German Housing Position 59

B. Political and Social Implications of the Air War 69

NOTE:

It is intended that the summaries presently presented before each of the divisions of the report shall be brought together to form a single master summary and that the detailed supporting material shall follow thereafter in the present order.

THE EFFECTS OF THE STRATEGIC BOMBARDMENT OF EUROPE

Statement of the Problem

1. To measure and interpret the results of strategic bomb damage to date and to evaluate the prospects for hastening the defeat of Germany by strategic bombing.

Summary of Conclusions

2. British and American bombing operations have emerged from the experimental phase and have begun to reduce the general level of output, the output of selected key industries, and the standard of living of important segments of the working population. Precise measurement of the results obtained is impossible. Relative orders of magnitude are useful, however, and tentative estimates are therefore presented.

a. There has been a 5 to 10 percent reduction in total industrial output of all sorts, chiefly as the result of the RAF area raids. This is too small a proportion of Germany's total production significantly to affect the flow of supplies to the fighting fronts (except through temporary dislocation of production schedules) but it does reduce the reserves of excess capacity, potential substitutes, non-vital uses, and other elastic factors which serve to protect the fighting fronts from the effects of bombing.

b. Results of somewhat greater strategic promise have been achieved in some of the key industries attacked by the USAAF. A 25 to 40 percent reduction in the production of fighter aircraft during the three months ending October, when taken together with the costly defensive burden which the Allied air attack has imposed on the GAF, has already greatly restricted and will further limit GAF capabilities on all fronts. Attacks on submarine construction during the first seven months of 1943 reduced production by 15 percent and destroyed the equivalent of 25 to 30 submarines; additional damage was done by RAF area-raids and by attacks on submarine bases; but direct attacks on submarines at sea are believed to have been more important in reducing U - boat effectiveness. A curtailment of about ~~15~~ 8 percent in aircraft-tire output may somewhat hamper operations, though surplus capacity may permit the effects to be evaded. In synthetic rubber, bearings, and petroleum products, the protective zone has been seriously narrowed. Damage to certain other industries, such as steel, has been substantial but is not thought to have had immediate military significance.

c. Civilian living standards have been most severely affected by the destruction of housing, especially in the Ruhr. For Germany as a whole, 1,800,000 people have been rendered homeless to date; in the five months ending August 1943, 600,000 were driven from their homes in the Ruhr alone. A nearly equivalent number is believed to have been evacuated. The number rendered homeless have not yet reached a point at which provision for them constitutes a serious economic burden but the social consequences and morale effect of separating, shifting, and intermingling families are likely to be important.

3. Several factors should make strategic bombing more effective in coming months than in those just past. The air forces will be larger, more experienced, and more efficient. Acquisition of Italian bases will bring large segments of German industry within much more accessible range. Vulnerability of the German aircraft position especially will be greatly increased; the fighter screen will be spread more thinly, and the most important aircraft plants will be much easier to reach. This is of the utmost importance because the future effectiveness of strategic bombing depends largely upon the speed with which we can overcome the GAF fighter defense and secure relative freedom of the air over Germany.

4. Future strategic bombing will undoubtedly reduce further the general level of German output. It is unlikely that the over-all reduction will be sufficiently great in itself to affect military operations over the next year. If the reduction in total output includes further marked decreases in the production of a few key war industries already dented, it, however, could seriously impair German military resistance. General economic dislocation and output loss will accentuate the effects of attack on specific industries.

5. Strategic bombing may also speed the end of the war through its effects on morale. Continued heavy destruction of housing and dislocation of civilian life will increase the war weariness of the masses and confirm their conviction of defeat, but the SS and the Gestapo will presumably prevent this from leading to mass action.

Nevertheless, the prestige of the Nazi party, which boasted that Germany would never be bombed and which is now incapable of coping adequately with the immense task of air raid relief, is bound to suffer. More important from the morale standpoint is the effect of bombing on the ruling elements. The success of bombing in curtailing the output of finished military items will emphasize the hoplessness of further resistance on the several fighting fronts. While the Nazis, who can expect mercy from no one, may wish to fight to the last, the industrialists and army leaders will desire to sue for peace as soon as it becomes apparent that prolongation of the war can only weaken their bargaining position. The bombing of key industrial centers and target systems will hasten this event.

Strategic bombing offers real promise of shortening the war. Data presently available do not permit the forecast, either in quantity or time, of specific results in terms of enemy fighting power, or in savings to our own forces. Yet there can be no doubt that well-coordinated air attack from both British and Italian bases, with the fullest possible concentration against key targets, would fully justify the necessary allocation of planes and crews. The first prerequisite is to gain control of the air over Europe. The speed with which this is accomplished will largely govern the timing of more far-reaching bombing results. Early acquisition of Italian bases is essential if strategic bombing is to have an opportunity of affecting military operations within the next twelve months.

SUMMARY OF SUPPORTING PAPERS

A. The Effect of Bombardment on the General Level of Output

1. The over-all effect of bombardment on the general level of industrial output is still quite small. It is estimated, however, that operations during the five months, April to August 1943, were on a scale sufficiently great to reduce the rate of industrial production in Germany between 5 and 10 percent. Damage in the earlier months of the year was of less importance.

2. Only about half of this loss — that due to direct damage and absenteeism — can be allocated to particular industries. If this loss were spread evenly over the industries in the bombed areas, national output would have been reduced about 8 percent in metal smelting, 6 percent in chemicals, 5 percent in mining, and between 1 and 4 percent in other critical war industries. These percentage losses are, however, subject to serious qualification. Loss from sources other than direct damage would tend to raise these percentages markedly. Differences in the vulnerability of various industries to bomb damage, however, make the assumption of equal incidence of loss peculiarly subject to error. In addition, the existence of excess capacity makes it possible to offset some of the loss by increased production elsewhere. Steel output is a case in point.

3. Daylight raids on selected industrial targets by USAAF bombers have caused considerably higher losses in the production of particular commodities. These are discussed below in Section III. Such losses, though they are bound to be small in relation to the total volume of German output of all kinds, are potentially of critical importance in their specific effects on Axis military strength.

B. Effects on Specific Industries

1. Military Materiel

a. Aircraft.

i. To meet her growing defensive requirements in all theatres, Germany has roughly doubled her production of both S/E and T/E fighters since June 1942. By contrast, production of all combat aircraft increased by 20 percent and that of long-range bombers fell 15 percent.

ii. At the same time, Germany has placed 61 percent of her fighter strength in the West and maintained that strength in the face of heavy losses sustained in meeting the bomber offensive. These heavy allocations to the West have reduced both the number of operating sqadrons and the scale of GAF operations on the Russian and Mediterranean fronts.

iii. The substantial impairment of GAF capabilities other than those of the Western fighter force outweighs in importance the industrial and economic damage inflicted by strategic bombing. This will probably remain true until the fighter defense over Germany has been materially weakened.

iv. The recent heavy attacks on A/C production facilities, repair factories, and airfields, have made important progress in this direction. Preliminary examination of results suggests that between 600 and 1,000 fighters will be lost from production in August, September, and October. This represents between 25 and 40 percent of total S/E fighter output. The impact of this loss on front-line strength will begin to be felt almost immediately.

v. The weakening of Germany's fighter defenses would be greatly facilitated by the seizure of North Italian bases. Acquisition of such bases would at the same time split the German fighter defense and bring Allied bombers within much easier striking distance of German fighter factories.

b. Tanks and Self-Propelled Artillery

i. The rate of output of tanks and self-propelled artillery has not been reduced so much as 5 percent. The true figure is probably not more than 3 percent.

ii. Since present tank strength equalls about a year's production, an output decline of 5 percent must be maintained for a full twelve months before strength in the field is reduced to that degree. This assumes that wastage continues at current levels.

iii. The enemy can offset the possibility of such loss by converting production facilities now used for other goods to the production of tanks if such a course is deemed desirable. Such conversion, however, would be at the expense of locomotive or truck output, and would be undertaken only if tank shortages become severe.

c. Motor Trucks.

i. The combined result of damage to truck and truck-engine plants, steel plants supplying truck factories, and plants supplying truck components may have been to reduce 1943 output between 10 and 20 percent below the output level which would have obtained in the absence of bombing.

ii. Since trucks in use and in storage (including unserviceable vehicles) are about 15 times as great as annual truck production, and since a large quantity of civilian trucks are available for requisition by the army, the effect of reduced truck output on German military capabilities in the next year will be minor.

iii. However, the effect on truck serviceability, and therefore on military capabilities, of decreased output of spare parts and destruction of important repair facilities (in plants producing new trucks as well as in separate plants) is important because the ratio of annual repair output to holdings is at least 1 to 1. The effect on military and industrial capabilities of such air-raid destruction is not measureable but is certainly more significant in the short trun than the effect of reducing new truck production.

d. Submarines

i. Attacks by the US Eighth Air Force on German submarine construction during the first seven months of 1943 reduced production during this period by 15 percent and destroyed the equivalent of from 25 to 30 submarines.

ii. RAF raids on cities where submarines and submarine components are manufactured has probably resulted in an additional destruction of 2.5 percent of production in this period, the equivalent of 4 or 5 submarines. The effect of these actions will be felt 4 to 6 months after the raids.

iii. Raids on submarine bases in Western France have lengthened the refitting period and reduced the number of operational U-boats to some extent.

2. Basic Industrial Materials

a. Oil.

i. Bomb damage suffered by petroleum facilities will not reduce German petroleum supplies in 1943 by so much as 500,000 tons. The principal damage has been to excess capacity only.

ii. A loss of 500,000 tons will necessitate no curtailment of military consumption, unless by localized disruption of distribution (as of Rumanian oil to the Eastern Front) or because of chance damage to specialty product plants (such as the lubricant plant at Schulau).

iii. Curtailment of industrial consumption is likewise unlikely. British and American oil experts in joint session in July of this year agreed that in 1943 Axis European supplies of petroleum products and substitutes would exceed probable consumption for all purposes by 2,000,000 tons (see Chart on following page). The resulting additions to stocks are expected to materialize largely in the second half of the year, when new synthetic capacity comes into operation. It is possible that this development will be counter-balanced by the effects of bomb damage and that reconstitution of stocks from the low levels of last winter will, therefore, be delayed.

b. Synthetic Rubber

i. As a result of the highly successful attack on the Hüls synthetic rubber plant on 22 June 1943, it is estimated that a loss equivalent to 7 or 8 percent of annual production plus imports has been inflicted upon the Axis. Percentage loss during the summer and early fall of 1943 will be much greater.

ii. Whether this loss has any net effect additional to the loss of Axis tire output depends on the rapidity with which tire capacity to replace plant damaged in the Hannover raid is activated. (See p. below.) It is clear, in any case, that no interruption of aircraft tire production can result from rubber shortage. The impact, if any, will fall upon truck and passenger tire output. Stocks of these types are more than sufficient to tide the Axis over the period of repair.

c. Rubber Tires

i. Aircraft Tires

(1) Bomber operations are believed to have caused a gross loss of output at the plants affected of approximately 52,000 aircraft tires. This quantity is about 16 percent of Axis annual output.

(2) Limited utilitization of stocks and fuller utilization of available excess capacity will, however, probably be sufficient to prevent a decline of enemy air activity.

(3) The cushion available to soften the effects of future raids is now much thinner than before the great raid on Hannover, and it may be anticipated that future attacks successfully executed in the near future would cut seriously into actual consumption of aircraft tires.

ii. Truck and Passenger Tires

(1) Although substantial loss of truck and passenger tire production resulted from bombing activity, stocks of such tires and excess capacity are fully adequate to supply such needs for many months.

d. Anti-Friction Bearings

i. Principally as a result of the great raid on Schweinfurt on August 17, a loss of production has been inflicted on Germany estimated to be equivalent to about 10 percent of annual output. The percentage loss of output in the next few months will, of course, be much heavier. These estimates are based on inadequate evidence and must be considered to be subject to a wide margin of error in either direction.

ii. To prevent the output of military items from feeling the full impact of this loss, it will be necessary for Germany to curtail use of bearings for industrial use severely. Excess capacity and surplus stocks are considered to be very small.

iii. Even with a sharp reduction of industrial uses, it will probably not be possible to maintain production of full supplies of all the types of bearings required for military products. It may be anticipated, therefore, that at least a temporary and limited reduction of the supply of bearings needed for airplanes, tanks and engines, and other munitions has been achieved. This is expected to affect the output of these items within as little as a month.

iv. Further reduction of total output would have far more serious consequences.

v. Full recovery from past raids is not expected before the beginning of 1944.

c. Steel.

i. The bomber offensive in 1943 caused a reduction of steel output in the areas raided which is estimated at over 4 million tons of steel. This gross loss is about 11 percent of the annual output in Axis Europe.

ii. Almost all of this loss has, however, been offset by the activation of idle capacity. The net loss of steel output is, therefore, likely to be inconsiderable.

iii. Actual production, after allowing for bomb damage, is considered sufficient to cover planned consumption. This, however, does not mean that considerable dislocation in the flow of specific orders to particular fabricating industries was not achieved.

iv. Even had a substantial net loss of output been achieved, the effect on the Axis would not have been serious. Consumption could be out as much as 25 percent without affecting military operations for a year.

f. Locomotives and Transportation.

i. During the first eight months of 1943, air operations caused destruction and damage to locomotives in Germany and western Europe[1] equivalent to the loss of 1,700 locomotives.

ii. The net reduction in the stock of locomotives, after allowing for other losses, retirements, and new construction, was only about 1,200. This represents a reduction of locomotive stocks of 2 percent.

iii. In spite of the small loss of locomotives, the general efficiency of the German transport system appears to have increased at least temporarily, due to the shortening of the Russian front and its gradual withdrawal toward Germany.

C. The Position of Civilians in Germany

1. The Effects of Bombing on the German Housing Position.

a. Before the outbreak of war, a serious deficit of housing facilities for families existed in Germany. The deficit was especially severe in civilian centers, particularly in cities experiencing war industry booms. During the war, this situation did not improve: even with no allowance for housing destruction by bombing, the excess of households over dwellings, was not reduced.

b. By 1 September 1943, it is estimated that an aggregate of 562,000 dwellings had been rendered uninhabitable. This number was 12 percent of all dwelling units in the cities bombed. In Ruhr cities, nearly 20 percent of all dwellings have been similarly destroyed by bombing. The bulk of this destruction was accomplished in the five months, April through August 1943.

c. Only a small percentage of those bombed out, and these almost exclusively workers, could be rehoused in temporary housing facilities; the main solutions to the problem were through doubling up and evacuation. If all families dehoused by air action were to be quartered in their own cities, at least an additional 25 percent of all families would be compelled to share quarters in bombed cities. In the Ruhr the corresponding figure would be at least 40 percent. Doubling up thus offered only a partial solution with respect to workers who had to remain in the bombed areas.

d. Extensive evacuation has been undertaken. It is now believed that some 500,000 persons were moved from the Ruhr and over 1,300,000 from all bombed cities. This evacuation has imposed an added burden on the German transport system and has made necessary the break-up of German households.

2. Political and Social Implications of the Air War

a. The psychological implications of the air war may best be understood by considering the latent conflicts inherent in the social structure of Germany.

b. The three potentially antagonistic groups in Germany are the Nazi party, the ruling class (including army leaders, industrialists, and large landowners), and the mass of the people.

c. The ruling class will work for the overthrow of the Nazi party when it has become convinced that such a course is the only way to preserve its prestige and privileges.

d. The opposition to the Nazi party held by the mass of the people will not become overt until there is some open break between the party and the ruling class, at which time it would move for a clean revolutionary sweep of both party and rulers.

e. By weakening confidence in the Nazi party, the air war has heightened social tension and intensified the basic antagonisms among these groups. While it will not alone bring about a political change in any direction, the air offensive is a powerful catalyst in an already unstable situation.]

THE EFFECTS OF THE STRATEGIC BOMBARDMENT OF EUROPE

I. INTRODUCTION

A. The Scale of the Attack.

During 1943 the air offensive over Europe has been passing from an experimental phase, in which results could only be evaluated generally, to a solid operative phase, in which results can be measured numerically if only approximately.

The RAF operations over the Ruhr especially have reached an impressive intensity and efficiency; the USAAF, operating on a large scale for only two months, has also achieved measurable and important results despite unusual weather handicaps and a bold and ingenious defensive fighter force.

If, as indicated in the following pages, Germany has not yet been brought to the verge of collapse by strategic bombing, it must be remembered that the Allied bombing forces have only recently grown in size and experience sufficient to make them effective operating instruments; that the weight of the RAF attack on Germany has been at an effedtive level for only six months, and that of the USAAF for only two months (at lease for distant targets); and that the lack of satisfactory bases outside Britain has seriously limited the range of effective attack. With the experimental phase passed, and with the acquisition of Italian bases, the Allied air forces should, in every month of good weather, increase the scale and effectiveness of their attack on the heart of German military power.

B. Methods of Evaluating the Results of Bombing.

Assessing bomb damage and its potentialities is a delicate task, chiefly because of the inherent difficulties in arriving at satisfactory methods and standards of measuring the physical results obtained. Fairly reliable estimates are available, however, of significant factors like the number of houses destroyed and damaged, the number of persons de-housed, the square-footage of industrial structures damaged, and even, in some leading industries, the percentage-loss of output which can be attributed directly to identifiable plant damage (without regard to the indirect effects on transport, labor efficiency, general repair costs, etc.).

The most serious problems of evaluation arise, however, not from the admittedly wide margin of error of these estimates, but from the difficulty in interpreting the significance of the quantitative data.

Interpretation of damage to plants manufacturing finished war-items is relatively easy. The aircraft industry is an example. Estimates of total production, of current wastage, and of operating strength are all available. An estimate of production lost through bomb damage thus permits assessment of the effect on the enemy's operating strength, if wastage remains unchanged, or on his scale of activity if strength is husbanded in the period of reduced output.

Somewhat similar conclusions can be drawn for the synthetic rubber, rubber-tire, petroleum, and ball-bearing industries, and certain others. The matter is complicated in these cases, however, by the partial use of the products for non-military or semi-military needs, which may be curtailed to meet immediate military requirements, and by lack of reasonably accurate knowledge of wastage rates and total stocks of the products in use or in reserve.

Interpretation of damage to plants not producing finished war-items becomes more difficult. It is possible to estimate with verying degrees of accuracy, as has been done below, loss of output by direct damage to such industries as steel, locomotives, chemicals. electrical equipment and textiles. These industries are deep in the economic structure and only a proportion of output finds its way into military end uses. The remaining uses are so ramified that their significance cannot be determined. Even more troublesome is the assessment of loss in output by damage to housing, urban communications, water and power supplies, and the like, and by the required repairs to these and other facilities.

At this point the difficulty arises of finding a common denominator by wich the over-all loss may be measured. The least unsatisfactory unit for this purpose, which is used here, is "man-days". The economic shortcomings of this unit are important; more serious is the fact that all man-days are not of equal military value. Those employed in producing finished war-items have much greater "war-content" than others; the significance of total man-days of output lost consequently varies according to the kinds of output affected. But it is plain that a large reduction in man-days' output is more significant than a small one. A high figure, of the order, say, of 20 to 25 percent would be generally accepted as significant. Such a figure might be conceived of as a "critical point."

The critical point must not be considered, however, as the point at which the enemy will collapse. Rather, as in the case of a critical point for a single industry, it has meaning only as the point beyond which additional losses will increasingly limit the enemy's military effectiveness.

A critical point, moreover, is not constant, but will vary widely in accordance with conditions. Among the factors on which it will depend are: the degree of current military pressure; the political and social situation; the kind of output affected; and the rate at which output is reduced, since a slow decline permits compensation for damage to key facilities by curtailment of less important operations, substitution, the use of alternative facilities, and so on.

C. Plan of the Study.

By the methods indicated above the results of the bombing of Germany to date are estimated and are summarized in the sections which follow.

The effect of bombing on the general level of production is first considered. In this section estimates are presented of the loss of output because of direct damage to plants, absenteeism, diversion of labor and materials to repairs, and secondary effects such as the interruption of the flow of materials and components, the need to relocate plants in safe areas, and the like. A number of factors that affect production could not be considered, however.

The effects of bombing on specific industries are then analyzed, first with respect to the direct military industries such as aircraft, tanks, trucks, and submarines, and then with respect to industrial materials and products of high military importance such as oil, rubber, tires, ball-bearings; and finally for such basic industries as steel and locomotives.

Both in the section on the general level of production and in the section on specific industries, the study attempts to determine the degree to which the critical point has been approached.

The final section of the study considers the effects of bombing on the position of the German home front, with particular reference to the housing situation and to changes in morale and political attitudes which may result from bombing. Lack of clear evidence makes any positive conclusions difficult, but an analysis of the German socio-political structure has been attempted in order to permit judgment of the possibilities of action.

II. THE EFFECT OF BOMBARDMENT ON THE GENERAL LEVEL OF OUTPUT

A. Summary

1. The over-all effect of bombardment on the general level of industrial output is still quite small. It is estimated, however, that operations during the five months, April to August 1943, were on a scale sufficiently great to reduce the rate of industrial production in Germany between 5 and 10 percent. Damage in the earlier months of the year was of less importance.

2. Only about half of this loss - that due to direct damage and absenteeism - can be allocated to particular industries. If this loss were spread evenly over the industries in the bombed areas, national output would have been reduced about 8 percent in metal smelting, 6 percent in chemicals, 5 percent in mining, and between 1 and 4 percent in other critical war industries. These percentage losses are, however, subject to serious qualification. Loss from sources other than direct damage would tend to raise these percentages markedly. Differences in the vulnerability of various industries to bomb damage, however, make the assumption of equal incidence of loss peculiarly subject to error. In addition, the existence of excess capacity makes it possible to offset some of the loss by increased production elsewhere. Steel output is a case in point.

3. Daylight raids on selected industrial targets by USAAF bombers have caused considerably higher losses in the production of particular commodities. These are discussed below in Section III. Such losses, though they are bound to be small in relation to the total volume of German output of all kinds, are potentially of critical importance in their specific effects on Axis military strength.

B. Factors Affecting Loss of Output

Economic loss due to air bombardment arises from a number of causes. The more important of these are:

1. Works are damaged and rendered partially or wholly useless until repaired.

2. Deaths, injuries, damage to communications and utilities, and housing damage cause a large amount of absenteeism over and above the unemployment stemming from damage to works.

3. A great amount of labor must be diverted to make good the damage to housing, plants and equipment, and the loss of industrial inventories and consumers' stocks.

4. If the production of the bottleneck materials and components has been interrupted, additional unemployment and loss of output will be caused at plants fabricating these goods.

5. To the extent that industries and persons are moved from bombed areas to safer locations, transportation resources

must be expended and further delay of production incurred.

British experience makes it possible to estimate the loss of output in Germany from the first three factors listed above. Additional loss will, of course, have been inflicted by the action of the other two causes. It goes without saying that the calculations summarized below are extremely rough approximations to the truth. Though an attempt is made to take account of some of the more important differences between British and German conditions, this cannot be done thoroughly or accurately. The estimates, nevertheless, are considered sufficiently valid to suggest the right order of magnitude of the damage thus far inflicted on German output in general.

C. The Over-All Loss From Air Attack[1]

1. General. The calculations of this section are based upon a special attempt to measure the effect of RAF raids on Germany during April, May, and June of this year. In that quarter, both the weight of attack and the effectiveness of operations considerably exceeded those achieved during the first quarter of 1943 and, indeed, during any earlier three-month period. Since June, the level of operations has been somewhat higher than in the quarter considered.

---

[1] Estimates in this section are based on data prepared by the Research and Experiments Division of the Ministry of Home Security.

2. Direct Damage and Absenteeism. During the second quarter of this year, there were twenty-five RAF attacks in force on 16 German cities. The bulk of the attacks was concentrated in the great industrial valley of the Ruhr. From aerial reconnaissance and bomb distribution it is estimated that the attacks damaged not less than 30.8 million square feet of industrial building - more than a square mile of industrial structure. The loss of production associated with this damage is placed at not less than 1,232,000 man-months of output.

In addition, the ordinary life of the region was severely shocked. About 12 percent of the population of the bombed cities were rendered homeless and another 21 percent found their homes damaged and requiring repair. It is estimated that in this situation many workers whose plants were undamaged would, nevertheless, absent themselves from work. A loss of 640,000 man-months is laid to voluntary absenteeism.

The sum of the time lost from these two causes - 1,874,000 man-months - is 27 percent of the working time of the raided region during the three months under review. It is true that a considerable part of this loss would be felt subsequent to the close of the quarter. It is useful and roughly valid, nevertheless, to treat the decline in output as if it had occurred during the second quarter.

3. **Cost of Repairs.** Loss of output from direct damage and voluntary absenteeism is but part of the total loss inflicted. English experience indicates that the repair of damage to industrial and residential structures and the replacement of stocks damaged by blast and fire requires a diversion of working time which is rather greater than that lost by plant damage and absenteeism. This suggests that an overall loss of some 4,000,000 man-months was probably caused by second-quarter raids. Part of this loss will, of course, not be confined to the raided areas but will be spread over the activities of the Reich as a whole. Since the normal industrial work-time in Germany in three months is approximately 75 million man-months, these estimates indicate a loss of something over 5 percent of the output of the entire German economy.

4. **Additional Factors.** These calculations, however, probably still understate the total loss suffered. This is true for a number of reasons:

a. It is considered doubtful that German repairs can be accomplished as rapidly as were repairs in Britain. Shortages of labor and materials, the strained state of transport and the dislocation caused by continuous raiding all militate against rapid recuperation.

b. The estimates of time lost because of plant damage neglect the generalized consequences of damage to transportation, power, and other utilities.

c. Additional costs were incurred in evacuating persons from the bombed areas (about 1.3 million people are thought to have been transferred to new localities in Germany) and in carrying through some limited relocations of industry.

d. Some disruption of the supply of scarce materials and components has undoubtedly occurred causing losses of output in undamaged fabricating plants.

e. The estimates of voluntary absenteeism are based on British experience and thus assume a level of morale comparable with that existing in the U. K. during the Battle of Britain. Two factors are relevant to a judgment of this point: (1) Germany has been subjected to far heavier and more continuous bombing than was Britain and faces the prospect of even heavier attack. (As much damage was done to housing in the second quarter of 1943 as in the previous fourteen months.) (2) On the other hand, the German labor market is more strictly organized and laggards can be coerced more effectively. No useful evaluation can now be made of these factors, but their importance for the problem must be recognized.

f. On the other side of the scale is the fact that strenuous efforts have undoubtedly been made to offset plant damage by activating excess capacity.

On balance, it appears reasonable to treat the 5 percent loss set out above as a minimum figure. We conclude, therefore, that the true overall loss of German output lies somewhere between a minimum of 5 percent and a maximum of 10 percent. These figures apply to the five months of heavy raiding, April through August. During the first three months of 1943, loss of output was on a smaller scale.

D. Loss in Particular Industries

Because of the general and indirect character of the causes accounting for much of the loss discussed above, it is manifestly impossible to allocate it to particular industries. Part of the loss, however - that part due to direct plant damage and voluntary absenteeism in the cities bombed - may be distributed roughly among the industries of these towns. As indicated above, these sources of damage caused an overall loss of at least 27 percent of the working time of the bombed cities. We can try to indicate the effect of this loss on the output of the major industries in the raided centers.

The chart on the following page shows by light shading the relative contributions made by the 16 bombed cities to total German output in 9 broad groups of industries estimated on the basis of 1939 employment data. These range from 29 percent of German output in metal smelting to 5 percent in textiles. If time lost in the bombed cities affected each of the industries equally, each would lose 27 percent of its local output. The loss of national output in each would be proportionate to the contribution of each local industry to the national total. The heavy shading of the Chart on the following page illustrates the result of such a calculation.

Two factors, however, operate to limit seriously the validity of such estimates: (1) the various industries differ widely in their vulnerability to damage by bombardment; and (2) the existence of excess capacity in some of the industries (steel is an example) affords an opportunity to reduce total loss by activating idle facilities.

III. EFFECTS ON SPECIFIC INDUSTRIES

A. Military Materiel

1. Aircraft

a. Summary. i. To meet her growing defensive requirements in all theatres, Germany has roughly doubled her production of both S/E and T/E fighters since June 1942. By contrast, production of all combat aircraft increased but 20 percent and that of long-range bombers fell 15 percent.

ii. At the same time, Germany has placed 61 percent of her fighter strength in the West and maintained that strength in the face of heavy losses sustained in meeting the bomber offensive. These heavy allocations to the West have reduced both the number of operating squadrons and the scale of GAF operations on the Russian and Mediterranean fronts.

iii. The substantial impairment of GAF capabilities other than those of the Western fighter force outweighs in importance the industrial and economic damage inflicted by strategic bombing. This will probably remain true until the fighter defense over Germany has been materially weakened.

iv. The recent heavy attacks on A/C production facilities, repair factories, and airfields, have made important progress in this direction. Preliminary examination of results suggests that between 600 and 1,000 fighters will be lost from production in August, September, and October. This represents between 25 and 40 percent of total

S/E fighter output. The impact of this loss on front line strength will begin to be felt almost immediately.

v. The weakening of Germany's fighter defenses would be greatly facilitated by the seizure of North Italian bases. Acquisition of such bases would at the same time split the German fighter defense and bring Allied bombers within much easier striking distance of German fighter factories.

b. Production. In order to meet the GAF's increasingly large defensive requirement in all theatres, production of both S/E and T/E fighters was nearly doubled between the middle of 1942 and the middle of 1943. Total production of combat aircraft increased only 28 percent, and output of long range bombers declined 15 percent.

The table which follows shows the changes in German combat aircraft production by type between July 1942 and July 1943.

Type	Output July 1942	Output July 1943	Percentage Change July 1942-July 1943
Long Range Bombers	510	435	-15
Dive Bombers	105	85	-19
Single Engine Fighters	410	810	+98
Twin Engine Fighters	110	210	+91
Miscellaneous	145	100	-31
Total Combat	1,280	1,640	+28

c. Diversion of Fighters to the West. The provision of defenses against the air offensive based on Britain has become during 1943 the heaviest task of the G.A.F. Its consistently intense fighter opposition, particularly to U.S.A.A.F. daylight missions, has been made possible through an expansion in the G.A.F. fighter establishment in the West and an acceptance by the G.A.F. of increasingly heavy attrition. Although 40 percent of total G.A.F. first-line strength is now on the Eastern Front, with 37 percent in the West and 23 percent in the Mediterranean, only 22 percent of combined fighter strength is on the Russian Front as compared to 61 percent in the West and 17 percent in the Mediterranean. This is illustrated in the chart on the following page.

While precise estimates of over-all German attrition in the West are not available, the claims of Allied pilots of enemy aircraft "destroyed" or "probably destroyed" in combat provide a rough indication of the general magnitude.[1]

---

[1] These claims cannot be taken as a reliable measure of over-all attrition; (a) because they may tend to overstate somewhat the number of aircraft destroyed in combat due to the difficulty of sifting out satisfactory totals from the conflicting and overlapping claims of different crew members, and (b) because aircraft destroyed in direct combat represent only a portion of total attrition, which also includes those lost enroute to or from combat, non-operational flying accidents, and aircraft destroyed on the ground by bombs. Since the above two factors tend to be offsetting, adjusted pilot claims may be accepted, in lieu of more exact estimates, as a rough approximation of minimum over-all attrition of the enemy air force.

If revised claims of the RAF and USAAF in these two categories are taken as a minimum approximation of over-all enemy attrition in the West from all causes, it then appears that total German losses on the Western Front during the first eight months of 1943 were at least 4,000 aircraft, of which approximately three-quarters, or 3,000 aircraft, were single-engine fighters. (See charts and tables on following pages.) Losses of this magnitude would represent about one-third of total combat production during the same period, but over half of single-engine fighter production. Of great importance is the sharp upward trend of USAAF claims since the first of the year. These claims for "destroyed" alone averaged about 730 per month in July and August compared to an average of less than 200 for the first four months of the year. Losses in August on the Western Front were nearly equal to total new production of fighters. The absorption of repair and training facilities, as well as of new production, in sustaining an enlarged and increasingly active fighter establishment, have helped to reduce the combat effectiveness and scale of operations of the GAF bomber force.

The expansion of German fighter output, though large, has been insufficient to keep pace with the growing defensive requirements in the Western theater. Thus, the flow of replacements in both fighter aircraft and pilots to the Russian and Mediterranean Fronts has been sharply curtailed, necessitating a reduction in the number of operating squadrons

and, more-

and, more particularly, in the scale of operations.

In general, therefore, the marked emphasis which has been placed on strengthening of air defenses against strategic bombing of Germany, has produced an increasingly serious impairment of GAF capabilities in other directions.

d. Defensive Capabilities. The substantial general impairment of GAF capabilities other than those of the Western fighter force is attributable chiefly to the Allied bomber offensive from British bases. To date, this accomplishment has outweighed in its effect on German military strength the industrial and economic damage inflicted by strategic bombing. So long as the GAF remains capable of sustaining its present scale of defensive effort, Allied strategic bombing can scarcely achieve truly decisive results. Particular importance attaches, therefore, to the recent attacks against fighter aircraft factories and related installations.

e. Loss of Aircraft from Allied Bombing. The RAF and United States Eighth Air Force have delivered increasingly heavy blows against German air strength in the form of bombing attacks on aircraft production facilities, repair factories, and air fields. A fairly complete tabulation of such missions during the 17 months between April 1942 and the end of August 1943 reveals the following rough totals for British-based Allied bombers:

Target	Number of Missions	Approximate Tonnage Dropped Over Targets
Aircraft final assembly and Airframe component plants	29	4,800
Engine assembly and component plants	6	2,300
Repair factories	16	1,000
Airdromes and air parks	115	3,400

These attacks on aircraft targets have been characterized by a marked upward trend in recent months.

Until the concentrated USAAF offensive against German S/E fighter plants began late in July 1943, the direct loss of output resulting from bomb damage to production facilities was not very significant. More important undoubtedly was the sacrifice of production forced by the transfer of certain facilities from such exposed locations as Bremen and Warnemunde in the West to relatively safer Eastern positions.

In the brief period from July 25 to August 13, 1943, the USAAF delivered by far the most concentrated blow to date against the German aircraft industry when it made eight attacks on six different final assembly and airframe component factories which jointly account for at least two-thirds of total S/E fighter production.[1] Aerial photographs reveal substantial damage to several of these plants, including those producing Messerschmidt fighters at Regensburg and Wiener Neustadt which jointly are credited with over half of total S/E fighter output. Preliminary examination of photographs suggests, as a rough gauge of the general magnitude of effect on production, that between 800 and 1,000 aircraft will be lost from production for August, September, and October out of a total of about 2,500 S/E fighters which might have been expected in the absence of these attacks. The impact of this production loss will begin to be felt on GAF front-line strength almost immediately.

---

[1] All attacks were made by the VIII Air Force except that against the aircraft factory at Wiener-Neustadt whichwas made by the IX Air Force.

Beyond this, it is not unlikely that the recent USAAF attacks on the important ball-bearing factories at Schweinfurt will gradually have some effect on aircraft output and repair.

The various attacks on repair factories, airdromes, and air parks have unquestionably caused the destruction of a considerable, though indeterminate number of aircraft. The damage to facilities is likely to be quickly repairable.

f. The Outlook. While the results of the recent Eighth Air Force attacks on German fighter aircraft plants represent only a portion of the minimum effects required to achieve a decisive weakening of Germany's fighter defenses, they may nevertheless be regarded as a most encouraging beginning. Progress would be facilitated by acquisition of bomber bases in North Italy. Attainment of such bases, first, will force a diversion of many GAF fighters from the West, thus making a less effective and more vulnerable fighter screen to oppose Allied attacks on both fronts. Second, it will place Allied bombers within much easier striking distance of German fighter factories. More than half of present fighter production lies within 250 miles of North Italy and about 80 percent is within roughly a 400-mile radius.

4

place Allied bombers within much easier striking distance of German fighter factories. More than half of present fighter production lies within 250 miles of North Italy and about 80 percent is within roughly a 400-mile radius.

4

2. Tanks and Self-Propelled Artillery

a. Summary. i. The rate of output of tanks and self-propelled artillery has not been reduced so much as 5 percent. The true figure is probably not more than 3 percent.

ii. Since present tank strength equals about a year's production, an output decline of 5 percent must be maintained for a full twelve months before strength in the field is reduced tothat degree. This assumes that wastage continues at current levels.

iii. The enemy can offset the possibility of such loss by converting production facilities now used for other goods to the production of tanks if such a course is deemed desirable. Such conversion, however, would be at the expense of locomotive or truck output, and would be undertaken only if tank shortages become severe.

b. Damage from Air Action. It is impossible to give a firm estimate of the extent to which German tank output has been reduced through recent bombing. A summary of the principal bombing incidents involving tank production follows. All the incidents resulted from RAF area raids.

Date 1943	Plant	Activity	Physical Damage
March 1	Daimler-Benz, Berlin-Marienfelde	tank assembly	very slight damage
March 8	MAN, Nürnberg	tank assembly	moderate damage
March-April	Krupps, Essen	engine production, possibly tank assembly	moderate damage
June 20	Maybach, Friedrichshafen	engine production, possibly tank assembly	moderate damage

In addition to the foregoing damage to tank assembly and engine plants, the bombing of important steel works is likely to have affected the delivery of steel and iron components (armor plate, turrets, gearboxes, tracks) to tank producers. Reductions in such deliveries, however, probably represent only temporary interruptions which are corrected as other steel plants assume responsibility for deliveries. It may be estimated that the entire 1943 campaign has not caused a reduction of output greater than 5 percent. The true figure is likely to be as low as 3 percent.

c. Significance of the Damage. Two facts limit the importance of even the minor degree of damage done:

i. Present tank ~~holdings are~~ strength is the equivalent of about twelve months production. A decline in the rate of output of 5 percent must, therefore, be maintained for a full year before tank strength is reduced to the same degree. Since it is unlikely that tank output fell by as much as 5 percent before the middle of 1943 (if then), tank strength will not fall 5 percent before the middle of 1944. All this, of course, assumes that wastage continues at the level currently prevailing.

ii. Facilities and labor capable of making tanks are available in large quantity in plants now devoted to the manufacture of trucks, locomotives, and marine engineering products. Thus, the enemy can easily avert a threat to tank strength by the reallocation of plant and labor to tank output. Since such a step would cut into the output of other high-priority goods, it is unlikely to be taken unless a serious shortage of tanks threatens.

3. Motor Trucks

a. Summary. i. The combined result of damage to truck and truck-engine plants, steel plants supplying truck factories, and plants supplying truck components may have been to reduce 1943 output between 10 and 20 percent below the output level which would have obtained in the absence of bombing.

ii. Since trucks in use and in storage (including unserviceable vehicles) are about 15 times as great as truck production, and since a large quantity of civilian trucks are available for requisition by the army, the effect of reduced truck output on German military capabilities in the next year will be minor.

iii. However the effect on truck serviceability, and therefore on military capabilities, of decreased output of spare parts and destruction of important repair facilities (in plants producing new trucks as well as in separate plants) is important because the ratio of annual repair output to holdings is at least 1 to 1. The effect on military and industrial capabilities of such air-raid destruction is not measureable but is certainly more significant in the short run than the effect of reducing new truck production.

b. Loss of Output from Bombardment. Truck production has probably been reduced by bombardment in three ways: (i) by direct hits on truck and truck engine plants, (ii) by damage to steel and component plants supplying truck assembly and engine plants, and (iii) through indirect losses caused by area-raids affecting truck factories. It is, unfortunately, impossible to assess the effects of any of these sources of loss with accuracy. Nevertheless, the extent of physical damage to truck factories, together with known loss of steel and component output, make it reasonable to suppose that 1943 production may be reduced to between 80 and 90 percent of the level planned for the year.

The following table lists damage to plants which may be assembling trucks. The rate of production at each of the plants is uncertain. It is believed unlikely, moreover, that all are engaged in truck assembly.

Plant and Location	Extent of Damage
Precision Raids	
Renault, Paris	Moderately heavy damage
Peugot, Montbeliard	Moderately heavy damage
Ford, Bordeaux	Moderate damage
Area Raids	
Krupp, Essen	Moderately heavy damage
MAN, Nurnberg	Moderate damage
Skoda, Pilsen	Moderate damage
Daimler-Benz, Berlin-Marienfelde	Very slight damage

In addition to assembling trucks the foregoing plants engage to some extent in truck repair and in the manufacture of spare parts. Such activities in these and in other plants, e.g., S.K.F., Schweinfurt, have been reduced through RAF and USAAF bombing with a consequent impairment of the serviceability of present holdings of trucks.

c. Significance of Losses of Output. The ratio of current annual output to total holdings of trucks is about 1 to 15--even lower than in the case of tanks. Hence, current reductions of truck output, even if maintained, can only affect the aggregate stock of trucks seriously after the lapse of a considerable period. In addition, civilian holdings of trucks are thought to be sufficiently large so that the major part of a decline in total truck holdings will affect transport requirements in lower-priority industries rather than military needs.

The effect on military capabilities of air-raid damage to plants producing spare parts and repairing trucks is less measureable but almost certainly more important than the effect of reducing new output. This is due to the fact that the ratio of annual repair output to holdings is at least 1 to 1.

4. SUBMARINES

a. Summary. i. Attacks by the US Eighth Air Force on German submarine construction during the first seven months of 1943 reduced production during this period by 15 percent and destroyed the equivalent of from 25 to 30 submarines.

ii. R.A.F. raids on cities where submarines and submarine components are manufactured has probably resulted in an additional destruction of 2.5 percent of production in this period, the equivalent of 4 or 5 submarines. The effect of these actions will be felt 4 to 6 months after the raids.

iii. Raids on submarine bases in Western France have lengthened the refitting period and reduced the number of operational U-boats to some extent.

b. Submarine Construction.

The time necessary to build a U-boat between laying of the keel and acceptance trial is roughly as follows:

Class	On the slips	Fitting out	Total
1,600 tons	12/13 months	6 months	19 months
1,000 tons	9/10 months	4 months	14 months
750 tons	8 months	3 months	11 months
500 tons	8 months	3 months	11 months

After completion, U-boats undergo a period of trials and training before becoming operational.

This period may take from 2 to 4 months and there are usually about 140 submarines in the Baltic preparing for operations.

During 1943 the Germans had a total operational fleet of approximately 300 U-boats of which more than 100 were actually operating at sea at any one time. Recently, however, these figures have both declined as a result of increasingly effective Allied operations directly against submarines at sea.

Operational U-boats have been based on Western France at Lorient, Brest, St. Nazaire, La Pallice and Bordeaux, with one or more flotillas based on each port.

c. Attacks on Submarine Bases. In the first seven months of 1943 the R.A.F. directed 16 raids, including a total of 3,162 planes carrying 9,235 tons, against submarine pens and bases. For the same period, the U.S. Eighth Air Force conducted 19 raids, with 1,352 aircraft carrying 2,209 tons, against the same targets. Approximately two-thirds of the weight of attack was against St. Nazaire and Lorient and extensive damage has been done to town and dock facilities. Items of damage include the following: demolished workshops and warehouses, damaged locks and sea walls, drydocks and auxiliary vessels sunk, railroad equipment and right of way damaged, utilities and services interrupted and impaired. The cities of St. Nazaire, Lorient, and Brest have been substantially evacuated.

It is not possible to assign a quantitative value to the effects of these attacks because of the nature of the target. Submarine pens are difficult to damage, and even when they are hit directly it is not possible to see whether the damage involved any submarines or to estimate the delays resulting from the destruction. Extensive delays in refitting and revitalizing U-boats must have resulted from the damage to town and harbor facilities, but in the absence of more direct information it can only be assumed that the result of these attacks has been to lengthen considerably the period of time necessary before the U-boats become operational. These delays would have affected the ~~siege~~ size of the submarine fleet at sea within the first six months of 1943.

d. Attacks on Submarine Construction Yards. In the first seven months of 1943, the US Eighth Air Force attacked submarine yards 13 times. In total, 1,086 American planes aimed 2,743 tons of bombs against the most important submarine building yards at Bremen, Flensburg, Hamburg, Kiel, Vegesack and Wilhelmshaven.

Detailed estimates of the damage done are available for only four of the 13 raids. Consequences of 9 raids are estimated from very incomplete reports.

It is believed that in the aggregate the American raids caused a loss of approximately 25 to 30 submarines in the year following the raids on the construction yards. As the damage done has been distributed among U-boats in the early stages of construction on the slips as well as to those completed and fitting out, this damage would have effect approximately 4 to 6 months after the raids, although the major effects of the raids would not be felt in the German fleets of operational U-boats for from 8 months to a year following the raids.

Thus, American attacks on submarine construction, in the first seven months of 1943 destroyed nearly 15 percent of the production of that period, although this rate of damage would not be felt until nearly 6 months after the attacks.

Attacks both on submarine bases and on construction yards are indicated in the table on the following page.

e. R.A.F. Attacks Affecting Submarines. The submarine yard is not a primary producer of any of the major components of the U-boat, but is essentially a hull-fabrication and assembly plant. All fittings and equipment, such as diesel engines, electric motors, batteries, and periscopes, are produced elsewhere. U-boat diesel engines are produced mainly at Augsburg, Nurnberg, Cologne, and Kiel. Electric motors are made at Berlin, Dortmund, Hamburg, and elsewhere. Accumulators are manufactured at Hagen, Cologne, and Hoppecke. Fire-control instruments, guns, radio equipment, and other components for the U-boat come from a variety of suppliers.

Air raids by the RAF have undoubtedly affected to some degree the supply of components, but no estimate can be made of the effect on submarine production or operation. The heavy British raids on Hamburg, Rodach, Bremen, and Kiel, submarine building centers, have undoubtedly imposed delays on construction programs.

Altogether, it may be reasonable to assume that 17 percent of the submarine program of the first seven months of 1943 has been destroyed by the combined effects of RAF and American raids.

Attacks on Submarine Bases and Construction Yards in 1943

	R. A. F.			U. S. A. A. F.		
	No. of Raids	No. of Planes	Tonnage	No. of Raids	No. of Planes	Tonnage
Submarine Bases						
Brest	2	24	21	5	126	340
Lorient	10	1966	4218	5	205	612
La Pallice . . .				2	105	237
St. Nazaire . . .	4	1172	2718	5	615	849
Helgoland				2	106	251
Total	16	3162	9235	19	362	2289
Construction Yards						
Bremen				1	102	254
Flensburg				1	55	134
Hamburg				2	122	216
Kiel				4	342	951
Vegesack				1	97	268
Wilhelmshaven . .				4	368	920
Total				13	1087	2743

B. Basic Industrial Materials.

1. Oil.

a. Summary. i. Bomb damage suffered by petroleum facilities will not reduce German petroleum supplies in 1943 by so much as 500,000 tons. The principal damage has been to excess capacity only.

ii. A loss of 500,000 tons will necessitate no curtailment of military consumption, unless by localized disruption of distribution (as of Rumanian oil to the Eastern Front) or because of chance damage to specialty product plants (such as the lubricant plant at Schulau.)

iii. Curtailment of industrial consumption is likewise unlikely. British and American oil experts in joint session in July of this year agreed that in 1943 Axis European supplies of petroleum products and substitutes would exceed probable consumption for all purposes by 2,000,000 tons (See Chart on following page.) The resulting additions to stocks are expected to materialize largely in the second half of the year, when new synthetic capacity comes into operation. It is possible that this development will be counterbalanced by the effects of bomb damage and that reconstitution of stocks from the low levels of last winter will, therefore, be delayed.

b. Damage by Air Action. The bulk of all damage to petroleum facilities was done by the single great raid on the refinery center of Ploesti in Rumania. Unfortunately, Axis capacity is sufficiently large so that the destruction effected by the raid merely reduced excess production capacity rather than actually cutting into current output.

Rumanian refining capacity before the raid amounted to

9,000,000 tons a year, virtually all at Ploesti. Expected Rumanian crude output in 1943 is 5,100,000 tons. The raid on Ploesti is now estimated to have caused "vital long-term damage" to from 40 to 45 per cent of Rumanian capacity. Rumanian capacity is thus adequate to process total crude production. Damage to storage tanks is thought to have cost the Germans 150,000 to 200,000 tons in products. The inevitable delays in transferring operations from damaged to undamaged facilities will result in a temporary output loss, but this should be made up in a few months, and need not be counted.

Additional losses, due to raids from British bases, may be placed at 200,000 tons at the most, and are probably less. The American raids on the Bergius plants at Gelsenkirchen and Wesseling were wholly unsuccessful. RAF raids on the Ruhr may have damaged a considerable number of petroleum installations, but the only known damage of consequence is that to two Fischer plants at Dortmund and Duisberg. Allowing for indirect losses of output, the total product loss in the Ruhr may be put at a maximum of 200,000 tons. The only other known damage of significance is that to the Leghorn refinery in Italy, now thought to be out of use. Damage to the lubricant plant at Schulau is of no quantitative importance, and the large refineries at Hamburg were not in the regions of heavy damage.

The total loss of current output is indicated in the table on the following page.

Raid		Loss (Metric Tons)
Ploesti		
Area-raids from British bases:		200,000
Hoesch, Dortmund		50,000
Sterkrade-Holten, Duisberg		30,000
Indirect effects of Ruhr raids	- a maximum of	120,000
Other (including temporary dislocation at Hamburg)	- less than	100,000
Total	- less than	500,800

c. Excess Capacity. Spare refining capacity in Europe is still believed capable of making up for this loss. French, Belgian, and Dutch refineries may have been dismantled to some extent for use in Russia and Hungary, but in that case repairs to the Rumanian refineries will be expedited.

d. Importance of the Raids. The two most significant results of the Ploesti and other raids are:

i. The amount of excess refining capacity in Europe has now been sharply reduced, and further destruction of such facilities will therefore result in a much greater product loss than heretofore.

ii. The raids to date may have succeeded in preventing German petroleum stocks from rising much above the uncomfortably low figure of last winter. Further raids in coming months, even if not extensive, may serve a similar purpose.

e. Potentialities of Future Raids. In the face of existing fighter opposition to raids from British bases the future task of reducing German petroleum supplies by an amount sufficient to hamper military operations is a formidable one. Total consumption of petroleum and substitutes in 1943, as shown in the chart above, will be about equally distributed between military and non-military at 9,000,000 tons each. The non-military uses break down about as follows:

Use	Thousands of Tons
Road transport	3000
Railways	500
Shipping	1000
Agriculture	1000
Industry	3000
Other, incl. household	500
Total industrial and civilian	9000

It is believed than in an emergency a 2,000,000 ton cut would be made in the above allocations before curtailment of military operations was permitted. About half of this cut would probably be made in Rumania and Hungary. Should Italy cease to be an Exis partner the German petroleum position would be improved to the extent of 1,400,000 tons yearly. A reduction of 3 to 5,000,000 tons in annual oil supplies must therefore be achieved if the immediate military effectiveness of German forces is to be significantly hampered.

The attainment of this goal from British bases is exceedingly difficuly. Not more than 20 per cent of synthetic oil and active refining lie within 500 miles of Britain. From North Italian bases, facilities accounting for additional 70 per cent of total petroleum output are within a 500 mile range. The early acquisition of North Italian bases is a necessity if anair offensive against petroleum targets is be be effective.

2. Synthetic Rubber

a. **Summary**. i. As a result of the highly successful attack on the Hüls synthetic rubber plant on 22 June, 1943, it is estimated that a loss equivalent to 7 or 8 percent of annual production plus imports has been inflicted upon the Axis. Percentage loss during the summer and early fall of 1943 will be much greater.

ii. Whether this loss has any net effect additional to the loss of on Axis tire output depends on the rapidity with which tire capacity to replace plant damaged in the Hannover raid is activated. (See p.   below). It is clear, in any case, that no interruption of aircraft tire production can result from rubber shortage. The impact, if any, will fall upon truck and passenger tire output. Stocks of ~~the latter~~ these types are more than sufficient to tide the Axis over the period of repair.

b. Attacks on Synthetic Rubber in 1943. RAF area-attacks on Mannheim and Cologne may have affected to a small degree the output of synthetic rubber from the I.G. Farben plants at these two cities. No specific reports of direct damage to installations have been received and interference to output from general damage to the town must be assumed to be small.

On 22 June, 1943, 170 B17s attacked the Hüls synthetic rubber plant at Westphalia dropping 243 thousand-pound G.P. bombs and 1,202 eight-hundred-pound GP.bombs. Bombbursts were seen across the whole of the target. Photographs taken a month after the raid showed hits on the boiler house and power plant; six gas holders were seen to be exploded; damage was visible to the gas plant and cooling tower, and to the acrylontrile and ethylene glycol derivative plants. A month after the raid only one of the five boiler house chimneys was smoking and none of the cooling towers was in use.

Aerial reconnaissance flown on 16 August, 1943, nearly two months after the raid, showed the Hüls plant to still be substantially inactive. There was little evidence of repair and there was no rolling stock in the main works area, all cooling towers were inactive and only one chimney was smoking. The pipe line had been partly repaired.

It is likely that a production loss equivalent to 4 or 5 months' total output from Hüls may be the overall consequences of the raid. As Hüls produced approximately 20 percent of the Axis output, this loss would amount to from 7 to 8 percent of annual production plus imports.

c. Significance of the Attacks. The chart on the following page compares the estimated pre-raid output of synthetic rubber in Axis Europe in 1943 with requirements and bomb damage. Estimates of pre-raid output made by various authorities range from a minimum figure of 189,000 tons per year to a maximum of 248,000 tons. If the maximum estimate is valid, the Axis possessed a comfortable margin over essential requirements of about 200,000 tons before the attack of 22 June. If the minimum estimate is nearer the truth, the Axis position was tight even before the raid.

Axis requirements for synthetic rubber contain a large cushion capable of absorbing the shock of an interruption to production. Nearly half of total consumption or 96 million tons is now thought to go for the maintenance of German army and industrial vehicles. To absorb the loss of 8 million tons of synthetic rubber (the minimum loss estimated above) would require only a 12 percent extension of the life of tires now in German Army and industrial service. In addition, stocks of truck tires are considered to be very large. No serious curtailment of German military activity, therefore, is to be anticipated from rubber output losses even as large as the maximum estimate suggested above.

Another limitation on the significance of the attack on synthetic rubber thus far is that the damage appears to be smaller than that wrought in rubber tire plants (see page , below). The existence of large excess capacity in the tire industry, may, however, mean that loss of synthetic rubber output will cause some over all reduction of tire production in excess of that caused by damage to tire facilities.

3. Rubber Tires

a. Summary.

i. Aircraft Tires. (1) Bomber operations are believed to have caused a gross loss of output at the plants affected of approximately ~~50,000~~ 25,000 aircraft tires. This quantity is about ~~16~~ 8 percent of Axis annual output.

(2) Limited utilization of stocks and fuller utilization of available excess capacity will, however, probably be sufficient to prevent a decline of enemy air activity.

(3) The cushion available to soften the effects of future raids is now much thinner than before the great raid on Hannover, and it may be anticipated that future attacks successfully executed in the near future would cut seriously into actual consumption of aircraft tires.

start here

ii. Truck and Passenger Tires (1) Although substantial loss of truck and passenger tire production resulted from bombing activity, stocks of such tires and excess capacity are fully adequate to supply such needs for many months.

b. Damage Inflicted by Bombing. Almost the entire loss in this industry was inflicted in the single great raid by the VIII Air Force on Hannover, on 27 July 1943. The table which follows summarizes the estimated results of this and other raids on tire targets.

Plant Affected	Date of Raid	Physical Damage	Loss of Output	
			Aircraft	Other
			(number of tires)	
Continental, Hannover	7/26/43	Severe damage to several buildings.	24,750	90,000
Michelin (Pirelli) Turin	2/4/43	Minor roof damage.	---	5,600
Harburg, Hamburg		Area raids[1]	---	1,500
Vorwerk, Wuppertal		" " 1	---	1,000
Pirelli, Milan		" " 1	450	6,000
Metzeler, Munich		" " 1	20	700
TOTAL			25,220	104,800
Gross loss as percent of normal annual output			8	3

c. Supply and Requirements. Axis requirements are about 300,000 per year for aircraft tires and roughly 4,000,000 per year for truck and passenger tires. It is believed that output rates prior to the air raids coincided with these demands.

---

[1] Only indirect consequences of area raids taken into account.

d. Stocks. About six weeks' stocks of aircraft tires exist at plants, in transit, and at aircraft maintenance and repair depots. There would probably be considerable reluctance to draw down these stocks. Stocks of passenger and truck tires exist on retired and active vehicles as well as at maintenance and repair depots. If motor transit were restricted, these stocks would last for at least a year.

e. Excess Capacity. In two French plants (Montlucon and Clermont-Ferrand), there is probably sufficient excess capacity to offset the loss of the three main Axis plants at Hannover, Hanau, and Milan in both aircraft and other tires. One of these plants (Dunlop), however, may already have been dismantled. If the two French plants were destroyed, small producers could still expand their output to meet the demand for passenger and truck tires (there may have to be some conversion from the former to the latter), but supplies of aircraft tires would fall far short of requirements.

f. Significance. If the French plants have not been dismantled, the severe blow dealt the Axis tire industry by the Hannover raid can largely be offset. Even if these plants can only be partially activated, however, the Axis air forces can operate at about their usual level by a limited draft upon stocks. At the end of three months, production and capacity should again be normal, but within that period aircraft tire supplies will be especially vulnerable to further attack.

4. Anti-Friction Bearings.

a. Summary. i. Principally as a result of the great raid on Schweinfurt on August 17, a loss of production has been inflicted on Germany estimated to be equivalent to about 10 percent of annual output. The percentage loss of output in the next few months will, of course, be much heavier. These estimates are based on inadequate evidence and must be considered to be subject to a wide margin of error in either direction.

ii. To prevent the output of military items from feeling the full impact of this loss, it will be necessary for Germany to curtail use of bearings for industrial use severely. Excess capacity and surplus stocks are considered to be very small.

iii. Even with a sharp reduction of industrial uses, it will probably not be possible to maintain production of full supplies of all the types of bearings required for military products. It may be anticipated, therefore, that at least a temporary and limited reduction of the supply of bearings needed for airplanes, tanks and engines, and other munitions has been achieved. This is expected to affect the output of these items within as little as a month.

iv. Further reduction of total output would have far more serious consequences.

v. Full recovery from past raids is not expected before the beginning of 1944.

c. Supply and Requirements. Axis' requirements for anti-friction bearings are actually somewhat in excess of the estimated pre-raid output of 143 million pieces per year. About 80 percent of new bearings go into military and naval equipment. The balance is used for industrial machinery of high priority. Though the latter uses can be curtailed to prevent production loss from falling wholly on military output, it will hardly be possible to shift from the production of industrial bearings to those used in military output without loss. Moreover, since industrial uses are themselves of high importance, failure to satisfy these demands would probably affect military output in the future.

d. Stocks and Excess Capacity. No considerable stock of bearings is thought to exist other than that in process, in transit, or awaiting transit. The fact that requirements were considered to be greater than consumption even before the raids indicates that effective excess capacity was negligible.

e. Conclusion. The heavy raid on Schweinfurt, combined with the effects of earlier raids, has probably lowered Axis anti-friction bearing output sufficiently to cause some reduction in the output of military equipment within a month following the raid, as well as a very sharp curtailment in non-military equipment output for a period of three to five months. This estimate must, however, be treated with great reserve because of the inadequacy of the data upon which it is based. Actual damage may have been either greater or less than represented above.

5. Steel.

a. Summary. i. The bomber offensive in 1943 caused a reduction of steel output in the areas raided which is estimated at over 4 million tons of steel. This gross loss is about 11 percent of the annual output in Axis Europe.

ii. Almost all of this loss has, however been offset by the activation of idle capacity. The net loss of steel output is, therefore, likely to be inconsiderable.

iii. Actual production, after allowing for bomb damage, is considered sufficient to cover planned consumption. This, however, does not mean that considerable dislocation in the flow of specific orders to particular fabricating industries was not achieved.

iv. Even had a substantial net loss of output been achieved, the effect on the Axis would not have been serious. Consumption could be cut as much as 25 percent without affecting military operations for a year.

b. Loss due to Bombing. The steel industry was the major industrial target of the great air offensive against the Ruhr. This campaign claimed the major part of RAF resources for the four months April through July.

Area-raids on Ruhr steel centers resulted in both direct damage and indirect losses of steel output. Two large plants with an annual capacity of 2,000,000 tons were so heavily damaged as to be considered useless for a year. Other Ruhr plants suffered losses from direct damage and from the indirect effects of bombing ranging from one to four months. The loss of output from area-raids on steel centers from January to August 1943 is summarized in the following table:

49

Raids on 8 Ruhr steel centers:	Loss of Output (metric ingot tons)
Direct damage	2,800,000
Loss of output from indirect effects of bombing.	1,400,000
Raids on 2 French steel centers.	50,000
Total "gross" loss	4,250,000
"Gross" loss as percent of output	11

Gross loss represents only the loss of output at plants affected by bombing. As indicated below, there is a great volume of excess steel capacity in Axis Europe. It is considered that enough of this excess capacity has been activated during the year to make the net loss of steel output inconsiderable. This does not mean that bombing did not dislocate the flow of finished steel shapes and forms to fabricating plants. A substantial redistribution of orders among plants was undoubtedly necessary and probably caused considerable delay in the receipt of steel at manufacturing plants. The effect of these delays upon munitions output may have been of some importance.

c. Excess Capacity. Axis excess steel capacity will be reduced from about 13 to 11 million tons as a result of the Ruhr bombings. This amount is smaller than the gross loss in output in part because of the completion this year of new capacity in Poland and Austria.[1] The bulk of the excess capacity is in the Belgium-Luxemburg-Lorraine area on a line running west and south of the damaged Ruhr plants.

---

[1] 2.8 million tons of annual capacity were destroyed; new construction added 0.8 million tons.

Although fuller utilization of the French and Belgian plants will probably be achieved, the success of the program depends on the prompt arrival of coke for the blast furnaces. An additional, but not serious, complication is the fact that the Axis will be replacing open hearth by Bessemer steel.

d. Consumption, Output and Requirements. Axis steel consumption is currently about 39 million ingot tons per year. Of this total, about 18 million tons are used for military products. The remainder is used for general industrial purposes. A large portion is allocated to the production of transportation equipment.

Through activating excess capacity, output has probably been maintained at a level approximately equal to consumption. As indicated above, this does not mean that some delays in the flow of steel to particular industries were not inflicted by bomb damage.

The quantity of steel needed to support the critical requirements of the fighting fronts is far smaller than total consumption. By failing to maintain industrial and transportation equipment and by cutting into low priority uses, consumption might be cut as much as 25 percent without influencing Axis military activity for a year's time.

C. Locomotives and Transportation

1. **Summary.** a. During the first eight months of 1943, air operations caused destruction and damage to locomotives in Germany and western Europe 1/ equivalent to the loss of 1700 locomotives.

b. The net reduction in the stock of locomotives, after allowing for other losses, retirement, and new construction, was only about 1200. This represents a reduction of locomotive stocks of 2 percent.

c. In spite of the small loss of locomotives, the general efficiency of the German transport system appears to have increased. at least temporarily due to the shortening of the Russian front and its gradual withdrawal toward Germany.

2. **Locomotive Damage through Air Action.** During the first eight months of 1943, locomotive targets absorbed a considerable portion of fighter ~~air~~ force resources. Approximately 1100 fighter sorties were made against locomotives. In addition, about 80 attacks have been made by bombers against railroad repair shops and marshalling yards. The greatest destruction, however, has resulted from night area-raids which have destroyed production facilities and damaged and destroyed locomotives in railroad yards and workshops.

1/ No basis for estimating damage to locomotives in Italy now exists.

The following table indicates the estimated numbers of locomotives lost to the Axis from these various causes during the first eight months of 1943:

Activity		Locomotives Lost[1] through Air Action
Fighter sorties		300
Attacks on railroad targets		80
Area-raids		1320
Standing on the way	1070	
Production loss	250	
Total, January-August 1943		1700

3. **Significance of Damage.** The loss of 1700 locomotives by air action cannot have been a serious matter for the German transport system. New construction is estimated to have exceeded retirements, and war losses other than bomb damage by some 400 units. Thus the net loss of locomotives in Germany and western Europe was only 1300 locomotives. This is but 2 percent of the Axis European stock of 66,000 units. ~~Thexxxxxthisxfigxxxx~~ The importance of this loss is somewhat greater than this figure suggests since the efficiency of new locomotives is considerably greater than that of the average unit in service.

[1] Since the repair of damaged locomotives is thought to consume, on the average, one-third the time needed to build a new locomotive, three damaged units are considered the equivalent of one locomotive destroyed.

The essential figures regarding the Axis locomotive position from January to August 1943 are presented in the table below and are illustrated in the chart immediately following:

	Number of Locomotives
Stock, Jan. 1, 1943	64,500
Construction, less retirements	1,300
War loss other than from air action	900
Stock, Aug. 31, 1943	63,200
Net loss of stock	1,300

The net loss of locomotives indicated above has had no noticeable efect on European traffic conditions. Indeed, except for short local interruptions caused by bombing, operating efficiency appears to have improved. at least temporarily. Relief has been afforded by shortening of lines along the Russian front. In addition the mild winter and the increased share of traffic carried by the waterways eased the situation in the first six months of this year.

IV. THE POSITION OF CIVILIANS IN GERMANY

A. The Effects of Bombing on the German Housing Position

1. Summary

a. Before the outbreak of war, a serious deficit of housing facilities for families existed in Germany. The deficit was especially severe in civilian centers, particularly in cities experiencing war industry booms. During the war, this situation did not improve: even with no allowance for housing destruction by bombing, the excess of households over dwellings, was not reduced.

b. By 1 September 1943, it is estimated that an aggregate of 562,000 dwellings had been rendered uninhabitable. This number was 12 percent of all dwelling units in the cities bombed. In Ruhr cities, nearly 20 percent of all dwellings have been similarly destroyed by bombing. The bulk of this destruction was accomplished in the five months, April through August 1943.

c. Only a small percentage of those bombed out, and these almost exclusively workers, could be rehoused in temporary housing facilities; the main solutions to the problem were through doubling up and evacuation. If all families dehoused by air action were to be quartered in their own cities, at least an additional 25 percent of all families would be compelled to share quarters in bombed cities. In the Ruhr the corresponding figure would be at least 40 percent.

Doubling up thus offered only a partial solution with respect to workers who had to remain in the bombed areas.

d. Extensive evacuation has been undertaken. It is now believed that some 500,000 persons were moved from the Ruhr and over 1,300,000 from all bombed cities. This evacuation has imposed an added burden on the German transport system and has made necessary the break-up of normal family life for hundreds of thousands of German households.

2. The Situation Before the Raids. With respect to housing the Germans made less adequate preparation for war than in the case of any other basic civilian need. In 1939, before the outbreak of war, the housing deficit in the Old Reich was at least 1.5 million dwelling units, or about 8.5 percent of the total number in the country. From 1939 to mid-1943 some 360,000 additional dwelling units became available through construction and conversion. This neglects the effect of air raids. Even so, the added units were less than the number normally considered necessary to maintain housing.

Although need for new housing units was below normal because of the draft and the consequent dissolution of significant numbers of households, it is reasonably certain that the excess of households over dwellings in mid-1943 would not have been less than in 1939, even in the absence of air raids.

Since housing is not a mobile factor, its adequasy must be appraised in specific cities and regions, rather than for the country as a whole. The housing shortage was more serious in German cities than in the country as a whole. Centers of war industry suffered from particularly severe housing shortages. In the larger cities of the Ruhr, for example, the shortage of dwelling units was at least 13 percent and in all the cities bombed by the RAF it was 10 percent, as compared with 8.5 percent for the Reich as a whole.

Some testimony to these shortages is provided by the measures taken by the Nazis to mitigate the housing problem in these areas even before the RAF bombing reached significant proportions. Houses which had, in earlier years, been converted into shops and office space were being reconverted; some attempts at space rationing in a few of the cities were instituted; large numbers of workers, German as well as foreign, were housed in temporary barracks located near industrial plants.

With the raids there naturally came an intensification of the measures previously taken to increase the use of existing housing accomodations. Space rationing was extended to new cities and more strictly enforced.

But "doubling up" offers only a partial solution to the problem of bombed out populations. If the attempt were made to rehouse all the population of the bombed cities in the houses still standing, at least 25 percent of the family units in the 37 bombed cities taken together (and at least 40 percent of those in the Ruhr) would be subjected to extreme congestion. Its consequences would be not only conflict among families and loss of privacy, but the hazards of contagion - with adverse effects on morale and public health. Such a degree of crowding is characteristic only of slum areas.

There is reason to believe that most of the workers who had to remain in the bombed areas were housed by doubling up. But for the bulk of the population dehoused, and for many others in the areas affected by bombing, the air offensive meant migrating.

It should be pointed out that, due to the large number of men called into the armed forces and to the fact that the foreign workers who in part replaced them, were housed in temporary facilities of one sort or another, there has been a reduction during the war in the population housed in permanent facilities. The ratio of such people to number of rooms declined. But, since the real demand for housing is by family units, this factor means simply that for the Reich as a whole there were at least before the raids, broad opportunities for controlled migration and space rationing. Room space could be found, usually in remote areas, but its utilization involved the social and psychological cost of breaking up family units.

3. Bomb Damage to Housing. The table on the following page shows cumulative totals of damage to German housing for the three periods from 1 March 1942 to 31 March, 4 July, and 1 September 1943. Dwellings rendered uninhabitable include those completely demolished and those showing major structural damage. In addition, an estimate is made for dwelling units requiring repairs although they remain habitable. It should be pointed out that the figures to July 1943 are based upon more complete information than are those for July and August. The data for these two months must be considered preliminary.

As of 1 September, some 560,000 dwelling units were rendered uninhabitable in the 37 cities bombed. This represents about 12 percent of the total number of dwellings in those cities. A corresponding percentage of the population was made homeless. In addition, over 1,500,000 homes sustained some damage necessitating repairs. For the Ruhr cities alone, the relative number of homes made uninhabitable was significantly larger, 19.8 percent of the total as compared with 12 percent for all bombed cities. The attached map shows the percentage of urban dwellings

SECRET

DAMAGE TO GERMAN HOUSING

a. All Bombed Cities

	From 1 March 1942					
	to 31 March 1943		to 4 July 1943		to 1 Sept. 1943	
	Number	%	Number	%	Number	%
Dwellings demolished	84,700	2.1	215,000	4.4	342,700	7.3
Dwellings suffering major damage	66,500	1.7	135,300	2.8	219,100	4.7
Total dwellings rendered uninhatitable	151,200	3.8	350,300	7.2	561,800	12.0
Dwellings needing minor repairs	653,900	16.4	1,069,378	21.8	1,685,310	36.0
Persons rendered homeless	539,000	3.9	1,173,508	7.5	1,834,800	11.7

b. Ruhr Cities Only

	Number	%	Number	%	Number	%
Dwellings demolished	20,900	3.6	103,600	11.0	124,753	12.3
Dwellings suffering major damage	17,000	3.0	60,200	6.9	73,267	7.3
Total dwellings rendered uninhabitable	37,900	6.6	163,800	17.4	198,020	19.6
Dwellings needing minor repairs	161,400	28.1	394,200	41.8	471,476	46.7
Persons rendered homeless	145,000	6.6	610,975	17.4	738,527	19.6

DAMAGE TO GERMAN HOUSING

a. All Bombed Cities

	From 1 March 1942					
	to 31 March 1943		to 4 July 1943		to 1 Sept. 1943	
	Number	%	Number	%	Number	%
Dwellings demolished	84,700	2.1	215,000	4.4	342,700	7.3
Dwellings suffering major damage	66,500	1.7	135,300	2.8	219,100	4.7
Total dwellings rendered uninhabitable	151,200	3.8	350,300	7.2	561,800	12.0
Dwellings needing minor repairs	653,900	16.4	1,069,370	21.8	1,685,310	36.0
Persons rendered homeless	539,000	3.9	1,173,805	7.5	1,834,800	11.7

b. Ruhr Cities Only

	Number	%	Number	%	Number	%
Dwellings demolished	20,900	3.6	103,600	11.0	124,753	12.3
Dwellings suffering major damage	17,000	3.0	60,200	6.9	73,267	7.3
Total dwellings rendered uninhabitable	37,900	6.6	163,800	17.4	198,020	19.6
Dwellings needing minor repairs	161,400	28.1	394,200	41.8	471,476	46.7
Persons rendered homeless	145,000	6.6	610,975	17.4	738,527	19.6

destroyed in the various administrative regions of the Reich. This percentage, it can be seen, varied from under 1 percent of urban housing in Hessen-Nassau to 32 percent in the region of Aachen.

During 1943, damage to housing has proceeded at an accelerated pace. In the three months from 31 March to 4 July, about as many houses were destroyed in all bombed cities as in the thirteen preceeding months. The preliminary figures indicate a still larger rate of destruction during July and August. The monthly rates of destruction in terms of percentage of dwellings for the three periods were 0.3 percent, 1.1 percent, and 2.4 percent respectively. In the Ruhr, the corresponding monthly rates were 0.5 percent, 3.9 percent and 1.0 percent. The decline in the rate of destruction in the Ruhr illustrates the geographical shift in the focus of RAF bombing in recent months. Although specific estimates cannot yet be presented, it is believed that as many as 500,000 persons moved out of the Ruhr, and over 1,300,000 out of all the bombed cities taken together. By and large, new housing facilities had to be found in relatively remote areas since the western provinces all had a rather tight housing position.

In practically all cases, the evacuation breaks up family units, since it was both necessary to retain workers in the bombed region and difficult to find accommodations for families in the new areas. This accelerated dissolution of German family units may be as costly to the Germans as the serious aggravation of the German housing position.

Somehow or other the worker is provided with shelter near his occupation. But he and members of his family, like soldiers, are not only subjected to the danger of air attack, but must increasingly endure the barrack-like existence of the military. This will reduce popular sympathy for the Nazi regime both in the bombed cities and in the remote areas to which evacuees are sent; it may also detract from worker productivity.

4. *The Significance of Housing Destruction*. Superimposed on the housing shortage before the raids, the destruction of dwelling units on such a scale created great problems for which the Germans were apparently ill-prepared. No attempt is now made to repair major damage to housing and even minor repairs are now accomplished with difficulty. Left unrepaired, these buildings can cause considerable discomfort and become serious health hazards during the winter months. New construction of permanent dwellings has been entirely eliminated. Until recently, at any rate, use was made of portable and mobile housing units for emergency housing of bombed-out persons. Priority for these was

given to essential workers, but, in total, only a small percentage of those dehoused could be provided for by these temporary facilities. In the future, the percentage of newly bombed-out persons so housed will be even smaller, since Germany is encountering difficulties in obtaining pre-fabricated housing.

B. Political and Social Implications of the Air War.

1. Summary. a. The psychological implications of the air war may best be understood by considering the latent conflicts inherent in the social structure of Germany.

b. The three potentially antagonistic groups in Germany are the Nazi party, the ruling class (including army leaders, industrialists, and large landowners), and the mass of the people.

c. The ruling class will work for the overthrow of the Nazi party when it has become convinced that such a course is the only way to preserve its prestige and privileges.

d. The opposition to the Nazi party held by the mass of the people will not become overt until there is some open break between the party and the ruling class, at which time it would move for a clean revolutionary sweep of both party and rulers.

e. By weakening confidence in the Nazi party, the air war has heightened social tension and intensified the basic antagonisms among these groups. While it will not alone bring about a political change in any direction, the air offensive is a powerful catalyst in an already unstable situation.

2. The Party, the Ruling Class, and the People. Air war impinges upon a given political and social structure

and must be regarded as intensifying or retarding basic trends which are already present. In the case of Germany there are three actually or potentially antagonistic groups which may be expected to play a crucial role in subsequent phases of the war: (1) the Nazi party control apparatus; (2) Germany's traditional ruling class, including army leaders, industrialists, and large landowners; and (3) the mass of middle and lower class citizens. The air war can most usefully be analysed in terms of its effects on the relations among these three groups.

The Nazis carry the chief responsibility for the war and all that it has brought with it. They took credit for successes in the past; now they must bear the onus of failures. Among the failures one of the most important is their inability to ward off devastating air raids with their attendant material hardship and emotional suffering. From this source springs a serious weakening of the Nazis' hold over the masses insofar as it is based on voluntary support and belief in ultimate victory; the reduction of Nazi rule to a basis of pure physical terror is hastened. Correspondingly, the usefulness of the Nazis to the traditional ruling class is diminished, and the latter are stimulated to look for a way of ousting the regime.

The loss of confidence in the regime is not confined to bombed areas. It spreads, through evacuees, to regions of evacuation and thence with diminishing intensity to the remainder of the population. Those areas which may become targets of bombing are naturally peculiarly sensitive. All of this creates a very serious problem for the authorities, and it is not to be supposed that they are remaining inactive in the face of it. The most effective countermeasures take the form of improving the speed and quality of protective and welfare work which, when effective, tends to bind thepeople to the party and the state organizations. There is evidence that the Nazis are devoting serious attention to this problem, but they cannot expect to offset in full the adverse effect of raids on their own position with the masses.

The air war consequently has increased the willingness of the traditional ruling class to sacrifice the Nazis if an opportunity should present itself. It must also deepen the already widespread conviction of eventual defeat, and discredit hope of a prolonged defensive war through gradual withdrawal to shorter frontiers. The strategy of withdrawal can economize manpower, but it increases proportionately Germany's vulnerability to bombing. Clearly, the bombs now falling on Germany are shattering the solidarity of her ruling elements and isolating the

Nazi party from its erstwhile allies among the upper classes.

The middle and lower classes are most directly affected by the air war, and this is particularly true in a country like Germany where attachment to items of family and personal property is intense. There is much evidence that the populations of heavily bombed cities are becoming increasingly war-weary and yearn for peace. For the present this attitude is not likely to give rise to action; terror keeps the people from expressing their feelings and from organizing for action. But in the event of a crack in the regime, or a falling-out between the Nazis and the army, the subdued popular opposition to the war might come quickly to the fore and play a crucial part in the subsequent course of events. As a result of the air war, the popular opposition is likely to be more revolutionary than it otherwise would have been, since more people than ever before are uprooted and have lost both social status and physical belongings. Thus the air war increases the numbers who have nothing to lose from a clean sweep of the old order, and in this way enhances the threat of revolutionary action when and if the popular opposition has an opportunity to come out into the open. This revolutionary threat is felt keenly by the traditional rul[illegible]lass, which must therefore be more anxious than ever to find a way out through a negotiated peace, or even through capitulation, before the existing social order has suffered irreparable damage.

If an attempt to oust the Nazis led to open hostilities between armed party formations and regular troops, popular opposition might come into the open, and an internal three-way struggle for pwoer might develop which could lead to a virtual paralysis of Germany's military strength. Air war by itself will not produce any of these results, but it is helping to bring them within the realm of possibility.

3. The Parallel of Italian Experiences. Some support of this view of the effect of air war on Germany can be derived from an analysis of Italian experience. In Italy the relation between the party and the people has never been as close as in Germany, nor has the Fascist repressive machine been nearly as efficient as the Nazi machine. Moreover, Italy has enjoyed virtually no successes in the war, and enthusiasm for its conduct has been noticeably absent from the outset. Finally, protective services against raids have been organized tardily and inefficiently, Hence the bombing of Italy struck with full force at a political and social structure similar to that of Germany but much

less compact and cohesive. The result was clearly to demoralize the masses and to alienate them from the Fascist regime. This in turn encouraged the traditional ruling groups of Italy to throw the Fascist leaders overboard in the hope of working out a compromise peace which will salvage something of their prestige and privileges from the catastrophe. The outcome of this manoeuver is still uncertain, but its motivation is clear; and there can be small doubt that the air war played an important part in setting the stage.